In drilling operations, stuck pipe incidents refer to situations where the string of pipes in the hole encounters abnormal restrictions, preventing axial movement. These incidents frequently lead to substantial financial losses and non-productive time, primarily because they are challenging to forewarn accurately. These events evolve in time from an incipient status, where the string encounters minor resistance to axial movement, to a complete stuck status, where the string cannot be moved whatsoever. Stuck pipe prediction refers to the problem of recognizing sticking symptoms in a timely manner, ideally when they are incipient, and assessing the severity of sticking. An early stuck pipe detection system not only implements stuck pipe prediction, but also generates early warnings based on the estimated severity. These warnings indicate when some preventative measures, such as circulating cuttings and cavings out, need to be taken to avoid the degradation of the condition into a complete stuck status. This research project aims to construct a digital tool that analyzes available drilling data for early recognition of sticking patterns and generates associated warnings in real-time.

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One of the most frequent mechanisms of stuck pipe is called ‘annular packoff’. In this mechanism, there is an excessive accumulation of a certain material in the annular space between the string in the hole and the wellbore wall. This situation can often be linked to one of two potential causes: wellbore instability or poor hole cleaning. In the first one, the rock formation crumbles, and the resulting rock fragments, known as cavings, block the annular space. In the second cause, the blocking material is the cuttings, generated by the action of the bit drilling the rock. To identify the abnormal accumulation of these materials, it is necessary to evaluate the returning volume of cuttings/cavings, as well as to determine their size and shape distributions. Traditionally, these tasks are carried out manually by a human, which results in a biased and often late characterization of these materials. This, in turn, undermines the ability to detect sticking conditions in a timely manner. This research project seeks to leverage 2D and 3D data, obtained with our cuttings sensor at UT, to have a real-time assessment of hole cleaning sufficiency and wellbore stability.

**Short:**

The excessive accumulation of cuttings (poor hole cleaning) or cavings (wellbore instability) in the annular space between the string in the hole and the wellbore wall often leads to stuck pipe incidents. To forewarn and avoid these situations, it is necessary to evaluate the returning volume of cuttings/cavings and to characterize their size and shape distributions. This research project seeks to leverage 2D and 3D data, obtained with our cuttings sensor at UT, to have an automated, real-time assessment of hole cleaning sufficiency and wellbore stability.

After drilling a hole section, the subsequent operation consists of installing the casing string. However, this task involves various challenges. Often times, the casing string cannot be lowered past a certain point, making it necessary to retrieve the string, or even leave it off bottom. The first case involves several hours, and therefore, a significant cost. In the second case, various risks are transferred to the subsequent section, including: reduced kick tolerance, potential wellbore instability, low annular velocity—which often results in poor hole cleaning—, and others. To prevent these situations, sometimes a dedicated string is lowered in the hole to correct undulations, smoothen ledges, and circulate cuttings and cavings out. However, this dedicated string also consumes a significant amount of time. The decision to take this preventative measure depends on the assessment of the risk of inability to run casing. If this risk is high, the drilling team opts for a wiper trip, amid its cost. Traditionally, such an assessment of the risk is done by a human. This has two disadvantages: (1) due to time limitation, the human can only analyze a limited amount of information, which, in turn, limits the comprehensiveness of the risk assessment; and (2) it often involves considerable subjectivity. This research project seeks the construction of a digital tool capable of evaluating the risk of inability to run casing in an automatic and comprehensive manner, at the same time it provides the drilling team with a clear connection between the risk assessment and the drilling variables.

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